PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

To:

Assistant Commissioner for Patents
United States Patent and Trademark Office
Box PCT
Washington, D.C.20231
ETATS-UNIS D'AMERIQUE

in its capacity as elected Office

Date of mailing (day/month/year) 30 June 2000 (30.06.00)	
International application No. PCT/EP98/07131	**Applicant's or agent's file reference** T+W 1/98
International filing date (day/month/year) 09 November 1998 (09.11.98)	**Priority date** (day/month/year)
Applicant WESTERMANN, Søren, Erik	

1. The designated Office is hereby notified of its election made:

[X] in the demand filed with the International Preliminary Examining Authority on:

17 May 2000 (17.05.00)

[ ] in a notice effecting later election filed with the International Bureau on:

2. The election [X] was

[ ] was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

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Authorized officer

Claudio Borton

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PATENT COOPERATION TREATY

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INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	**FOR FURTHER ACTION** see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
T+W 1/98		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/EP 98/07131	09/11/1998	
Applicant		
TØPHOLM & WESTERMANN APS et al.		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 4 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

   a. With regard to the **language,** the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

   [ ] the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

   b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

   [ ] contained in the international application in written form.

   [ ] filed together with the international application in computer readable form.

   [ ] furnished subsequently to this Authority in written form.

   [ ] furnished subsequently to this Authority in computer readble form.

   [ ] the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

   [ ] the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. [ ] **Certain claims were found unsearchable** (See Box I).

3. [ ] **Unity of invention is lacking** (see Box II).

4. With regard to the **title,**

   [ ] the text is approved as submitted by the applicant.

   [X] the text has been established by this Authority to read as follows:

   METHOD FOR IN-SITU MEASURING AND CORRECTING OR ADJUSTING THE OUTPUT SIGNAL OF A HEARING AID WITH A MODEL PROCESSOR AND HEARING AID EMPLOYING SUCH A METHOD

5. With regard to the **abstract,**

   [ ] the text is approved as submitted by the applicant.

   [X] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No. 1

   [X] as suggested by the applicant.

   [ ] because the applicant failed to suggest a figure.

   [ ] because this figure better characterizes the invention.

   [ ] None of the figures.

Box III TEXT OF THE ABSTRACT (Continuation of item 5 of the first sheet)

The application relates to a in-situ method to measure and correct or adjust the sound signal presented to the eardrum by means of a hearing aid and a hearing aid employing such a method. The hearing aid comprises at least one microphone (1), at least one digital signal processor (2) for transforming the microphone signal into a transformed signal according to a desired transformation function, a receiver (3), a sensing means (4) for sensing the sound signal appearing in front of the eardrum and at least one comparison means (5). A model of the electroacoustic system of the ear and the hearing aid is established and stored in the hearing aid, which model simulates the sound signal in the earcanal in front of the eardrum. This model is adapted in response of an error signal generated in case the difference between the representation of the sensed signal and the simulated sound signal is above a predetermined threshold.

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PATENT COOPERATION TREATY

REC'D 20 FEB 2001
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INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
T+W 1/98		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/EP98/07131	09/11/1998	09/11/1998
International Patent Classification (IPC) or national classification and IPC H04R25/00		
Applicant TØPHOLM & WESTERMANN APS et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 4 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 6 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
   - VI ☐ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
17/05/2000	16.02.2001
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Nieuwenhuis, P Telephone No. +49 89 2399 8968

Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/EP98/07131

I. Basis of the report

1. This report has been drawn on the basis of *(substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments (Rules 70.16 and 70.17).)*:
Description, pages:

1,3-9	as originally filed			
2,2a	as received on	13/10/2000	with letter of	12/10/2000

Claims, No.:

1-17	as received on	13/10/2000	with letter of	12/10/2000

Drawings, sheets:

1/2,2/2	as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

   These elements were available or furnished to this Authority in the following language: , which is:

   - ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
   - ☐ the language of publication of the international application (under Rule 48.3(b)).
   - ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

   - ☐ contained in the international application in written form.
   - ☐ filed together with the international application in computer readable form.
   - ☐ furnished subsequently to this Authority in written form.
   - ☐ furnished subsequently to this Authority in computer readable form.
   - ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
   - ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:
- ☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

   (Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-17
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-17
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-17
	No:	Claims	

2. Citations and explanations
   see separate sheet

Re Item V

Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. The application relates to a in situ method (claim 1) to measure and correct or adjust the sound signal presented to the eardrum by means of a hearing aid and a hearing aid (claim 11) employing such a method. The hearing aid comprises at least one microphone (1), at least one digital signal processor (2) for transforming the microphone signal into a transformed signal, a receiver (3), a sensing means (4) for sensing the sound signal appearing in front of the eardrum and at least one comparison means (5).

   Such a method and hearing aid are known from e.g. US-A-4 596 902 (D1).

2. The features that render the subject-matter of claims 1 and 11 novel and inventive relate to:

   A model of the electroacoustic system of the ear and the hearing aid established and stored in the hearing aid, which model simulates the actual sound signal in the earcanal in front of the eardrum. This model is adapted in response of an error signal generated in case the difference between the representation of the sensed signal and the model is above a predetermined threshold.

   Thus adaptation in real time to instantaneous variations of the entire electroacoustic system, comprising of the ear and the hearing aid is possible.

3. None of the cited documents discloses these features.

4. Claims 2-10 and 12-17 are dependent on claims 1 and 11, respectively and as such also meet the requirements of the PCT with respect to novelty and inventive step.

PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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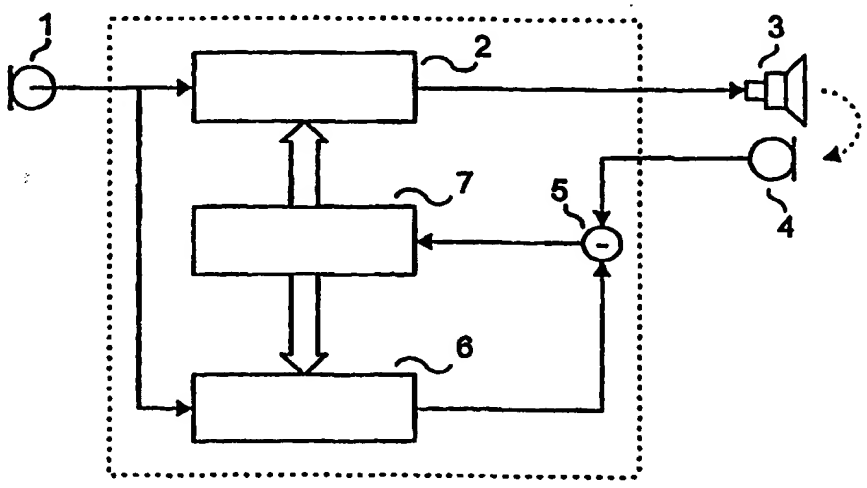
(81) Designated States: AU, CA, JP, US, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published

With international search report.

(54) Title: METHOD FOR IN–SITU MEASURING AND CORRECTING OR ADJUSTING THE OUTPUT SIGNAL OF A HEARING AID WITH A MODEL PROCESSOR AND HEARING AID EMPLOYING SUCH A METHOD



(57) Abstract

The application relates to an in–situ method to measure and correct or adjust the sound signal presented to the eardrum by means of a hearing aid and a hearing aid employing such a method. The hearing aid comprises at least one microphone (1), at least one digital signal processor (2) for transforming the microphone signal into a transformed signal according to a desired transformation function, a receiver (3), a sensing means (4) for sensing the sound signal appearing in front of the eardrum and at least one comparison means (5). A model of the electroacoustic system of the ear and the hearing aid is established and stored in the hearing aid, which model simulates the sound signal in the earcanal in front of the eardrum. This model is adapted in response of an error signal generated in case the difference between the representation of the sensed signal and the simulated sound signal is above a predetermined threshold.

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METHOD FOR IN-SITU MEASURING AND CORRECTING OR ADJUSTING THE OUTPUT SIGNAL OF A HEARING AID WITH A MODEL PROCESSOR AND HEARING AID EMPLOYING SUCH A METHOD

The invention relates to a method to measure and correct or adjust the sound signal presented to the eardrum by means of a hearing aid in the operational position, including at least one microphone, at least one digital signal processing system comprising at least one digital signal processor for transforming the incoming sound signal into a transformed signal in conformity with the desired transformation function, and at least one receiver and a power supply, and having at least one sensing means for sensing the signal appearing in front of the eardrum, and at least one comparison means.

Measurements and corrections for linear or nonlinear distortions in hearing aids are known from the prior art, particularly from German Publication DE 28 085 16, which discloses a hearing aid, which in addition to the receiver uses a measurement microphone or probe microphone, which could be separate from the receiver or incorporated or integrated into the receiver. This microphone picks up the sound environment in the ear canal in front of the eardrum and is used for the compensation of linear and/or nonlinear distortions of the signal.

The instantaneous analog values of the output signal of the probe microphone are applied at one input of a differential amplifier, the second input of which receives the undistorted output signal of a preamplifier of the hearing aid. The output signal of the differential amplifier is then applied as a correction voltage which is added to the input signal of the output amplifier, resulting in a corrected output signal from the receiver.

Thus, the probe microphone and the differential amplifier are part of a feedback loop for correcting distortions of the output signals of a hearing aid.

However, this known system can not adapt itself in real time to instantaneous variations of the entire electroacoustic system, comprising of the ear and the hearing aid, preferably a programmable or program controlled digital hearing aid system.

Therefore, it is an object of the present invention to create and develop a novel method for an instantaneous measurement and correction or adaptation of the sound environment in front of the eardrum, even including occlusion effects and other foreign signals or sounds influencing the sound field in front of the eardrum, to a desired sound signal.

A model function of this type may be developed and one may even be able to predict or anticipate changes in the sound environment in front of the eardrum by such a method.

These objects are achieved by means of a method of the kind referred to above which in accordance with the invention is characterized by establishing a model of the electroacousic system of the ear and the hearing aid, said model simulating the actual sound signal in the ear canal in front of the eardrum, and storing said model in the hearing aid, sensing the actual signal appearing in front of the eardrum, converting said sound signal into a digital representation and feeding it back to an input of the digital signal processing system, comparing said digital representation of said sensed signal with said model in said comparison means and, in case there is a material difference between the sensed signal and the model, to generate an error signal for adjusting said model to the actual sound environment in front of the eardrum.

It is particularly advantageous, if the entire operation is performed digitally, which would lead to large scale integration of most or almost all components of the system.

Further advantages of the invention will become apparent from the remaining claims and the description.

The invention will now be described in detail with respect to several embodiments shown in the attached drawings.

In the drawings

Fig. 1 shows schematically a first embodiment of a hearing aid to be used for practising the inventive method;

Fig. 2 shows schematically a second embodiment of such a hearing aid;

Fig. 3 shows a third embodiment of said hearing aid and

Fig. 4 shows another embodiment of said hearing aid .

In the hearing aid as shown schematically in Fig. 1, the acoustical sound pressure prevailing in the environment surrounding the user is picked up by an input transducer of the hearing aid, in this case a microphone 1. The output signal of microphone 1 is applied to a processing system, preferably a digital signal processing system operating in accordance with the present invention and containing at least one digital signal processor 2, which processes the incoming signal in accordance with the hearing deficiency of the user and to the prevailing acoustical environmental situation. The output of the digital processor 2 is passed on to an output transducer, in this case a receiver 3.

The sound pressure levels in the earcanal are sensed by at least one sensing means, in this case by a probe microphone 4 that can be separate from the receiver, or incorporated into the receiver.

Equally, the receiver could be used also as a probe transducer or as such in combination with a probe microphone.

Principally, while the drawings show a hearing aid for performing

the inventive method as a single channel hearing aid, it is to be understood that, obviously, the invention is by no means limited to single channel hearing aids but is, preferably so, also applicable to multi-channel hearing aids.

Also it is to be understood that in place of one input transducer or microphone several microphones could be provided as well as any other conceivable type of input transducer producing an input signal.

The output transducer could as well be any type of output transducer that produces an output signal, f.i. a sound signal in front of the eardrum.

Furthermore, analog to digital and digital to analog converters would have to be employed, where required, preferably in the form of sigma-delta-converters.

The sensing means, i.e. the probe microphone 4 is directly or indirectly connected to a comparison means 5. Furthermore there is shown a model processor 6 which receives one input signal from the input side of the digital signal processor 2 or from the output of the microphone 1. The model processor 6 is also connected to the comparison means. When, initially, establishing the model function, the entire system has to be taken into account, i.e. the complete ear including the outer ear with the earlobe as well as the eardrum and the inner ear and also the hearing aid. This means that, when establishing the model in the customary way all facets of the ear and the hearing aid have to be taken into consideration. This model then may perform a representative simulation of the actual sound signal in front of the eardrum.

The establishment of such a model is a well known scientific research tool.

However, in the present case, this model, once it is established, as a model function, it is to be stored in the hearing aid, preferably in the model processor 6.

It has to be understood that this model processor 6, at least basically or in parts may operate in a manner similar to the operation of the digital signal processor 2 in conjunction with the output transducer or receiver and the sensing means.

This process, of course, is adjustable by the operation of the entire circuitry.

Finally, preferably in combination with the model processor 6 a parameter adjustment processor 7 is provided and is also connected to the comparison means.

Of course, in a preferred embodiment of such a hearing aid to be used for practising the inventive method, all operations in the various circuits are performed digitally. This means that between the microphone 1 and the digital signal processor 2 an analog to digital converter has to be provided. The same applies to the connection between the sensing means 4, i.e. the probe microphone and the comparison means 5. Since the model processor 6 is also operating digitally, the signals applied to the model processor 6 have to be in digital form or must be converted into digital form in the model processor 6. The parameter adjustment processor 7 will also be operated digitally with the same requirements.

In operation, after establishing the model function in the model processor 6, the ambient sound spectrum prevailing is picked up by the microphone 1 and operated on in the digital signal processor 2 in accordance with the parameters set into the hearing aid, transforming the incoming sound signal into a desired sound signal in front of the eardrum by means of an output transducer, i.e. the receiver 3.

The sensing means 4, i.e. the probe microphone senses the signal or the sound pressure level in front of the eardrum. The output signal of the probe microphone is then, either directly or indirectly applied to the comparison means 5 which also receives the signal from the

model processor 6 as a second input signal. If, at the comparison means 5, a material difference is detected between the two signals, an error signal is developed. This error signal is applied to the parameter adjustment processor 7 where it is analized. In accordance with this analysis of the error signal, the parameter adjustment processor 7 may then change the parameter set controlling the transfer characteristic of the digital signal processor 2 and/or the model processor 6 to adapt or change the model as well. For this purpose the parameter adjustment processor 7 is also connected to the digital signal processor 2 and to the model processor 6.

In this analysis the parameter adjustment processor 7 determines whether the error signal is inside an acceptable range of values or not. If the error signal is outside an acceptable range of values, the parameter adjustment processor operates on the digital signal processor 2 to change its set of parameters and, eventually, sets up a new acceptable range for the error signal and/or adapts or corrects the process in the model processor 6 to change or adapt the model.

This means that the process in the parameter adjustment processor 7 is changed to an improved process and thus also to an improved model in the model processor 6. This new model function now controls the digital signal processor 2 to adapt the output of the receiver 3 in such a way as to approach the signal in front of the eardrum as closely as possible and, of course, preferably in real time, to the desired sound signal in front of the eardrum.

It goes without saying that the operation between the units 5, 6 and 7 can be analog or digital, with the corresponding analog to digital and digital to anlalog converters in the corresponding locations This is state of the art.

After this detailed description of the circuitry and operation of fig. 1 the following figures and their operation can be described in less detail,

the more so as several processors are substantially the same and are designated with the same reference numerals.

All systems variations, i.e.single channel or multiple channel hearing aids which were already described with respect to fig. 1 apply, mutatis mutandis, to figs. 2, 3 and 4 as well and need not to be repeated.

Fig. 2 shows a similar hearing aid for performing the inventive method, comprising an input transducer, a microphone 1, a digital processing system including f.i. at least one digital signal processor 2, an output transducer 3, a sensing means 4, a comparison means 5, a model processor 6 and a parameter adjustment processor means 7, which prefereably is incorporated into the model processor 6.

Additionally, a further modification means or correction means 8 between the output of the digital signal processor 2 and the output transducer 3 for further influencing the output signal of the output transducer 3 in real time, is also connected to the comparison means 5 to control the input signal for the output transducer 3.

The possible material difference between the output signal of the sensing means 4 and the output signal of the model processor 6 and the processor 7 in comparison means 5 results again in an error signal which will also directly influence the output signal of the digital signal processor 2 via the modification means 8 and consequently the input signal to the output transducer3. This will diminish or reduce the error signal almost immediately.

This may be of particular interest in case the error signal is the result of an erroneous transmission of an audio signal through the hearing aid into the sensing means, i.e. the probe micrpohone 4.

This error signal may also have been caused by other sources which may introduce a sound signal into the earcanal or the ear, f.i. occlusion effects, which could be overcome immediately.

The hearing aid shown in fig. 3 is in many respects quite similar to the hearing aids shown in figs. 1 and 2 so that all generic remarks made in connection with those figs. apply also in fig. 3.

However, the hearing aid shown in fig. 3 differs in a material way from the previous figures.

One input signal for the model processor 6 is now derived at the output of the digital signal processor 2 and not from its input side. Thus, the model processor 6 does not have to emulate similar processing capabilities as provided in the digital signal processor and therefore can be less complex.

However, both systems have their advantages. The system in figs. 1 and 2 gives more time to process the signal in the model processor 6, for generating the model, whereas deriving the input signal for the model processor 6 from the output of the digital signal processor 2 reduces the processing time in the model processor 6, and reduces the complexity of the model processor 6, that would have been required.

Finally, fig. 4 shows another embodiment of a hearing aid for performing the inventive process.

Fig. 4 shows an arrangement similar to the one shown in figs. 1 and 2, where the model processor 6 is connected to the input side of the digital signal processor 2 or even to the output side of the microphone 1.

However, the sensing means, i.e. the probe microphone is now connected to a probe signal correction processor 9 which could include an analog to digital conversion means and even means for frequency characteristic correction and frequency band splitting, if so required. Such preprocessing for frequency characteristic correction can be of real advantage because it may then not be necessary to correct the individual probe microphone characteristics in the model processor 6.

As can be seen from fig. 4 the probe signal processor 9 may be controlled and adjusted from parameter adjustment processor 7. The pro-processed probe microphone signal and the output from the model processor 6 are both applied to comparison means 5. In case there is a material difference between the two signals applied to comparison means 5, an error signal is developed to influence the parameter adjustment processor 7 in the way as described in connection with figs. 1 and 2.

At the same time, the error signal developed at comparison means 5 influences the process in the parameter adjustment processor 7 which results in an adjustment of the model in the model processor 6 and determines the transmission characteristic of the digital signal processor 2 and finally, of course, the input signal to the output transducer, i.e. the receiver 3 and thus the sound signal in the earcanal in front of the eardrum as closely as possible to the desired sound or sound pressure levels.

Generally, it may be said that in fig. 1 there is shown only one input to a model processor 6, one comparison means 5 and, of course, one error signal developed from a comparison of the output signal of the sensing means and the model from the model processor 6 and in conjunction with the function in parameter adjustment processor 7. There are, of course, possibilities to use multiple processors to create multiple error signals as well.

With this new method a more sophisticated adjustment or correction of the sound signal appearing in front of the eardrum, almost in real time, will be possible.

CLAIMS

1. Method to measure and correct or adjust the sound signal presented to the eardrum by means of a hearing aid in its operational position, including at least one microphone (1), at least one digital signal processing system comprising at least one digital signal processor (2) for transforming the incoming sound into a transformed signal in conformity with a desired transformation function, having at least one receiver (3) and a power supply, as well as at least one sensing means (4) for sensing the signal appearing in front of the eardrum, and at least one comparison means (5), characterized by

   A establishing a model of the electroacoustic system of the ear and the hearing aid, said model simulating the actual sound signal in the earcanal in front of the eardrum, and storing said model in the hearing aid,

   B sensing the actual signal appearing in front of the eardrum, converting said sound signal into a digital representation and feeding it back to an input of the digital signal processing system,

   C comparing said digital representation of said sensed signal with said model in said comparison means (5) and, in case there is a material difference between the sensed signal and the model, to generate an error signal for adjusting said model to the actual sound environment in front of the eardrum.

2. Method according to claim 1, characterized by using said material difference from said comparison as an error signal to adaptively modify the process in said digital signal processor (2) by minimizing said error signal.

3. Method according to claim 1 or 2 characterized by storing said model in a model processor (6) and using said material difference from said comparison as an error signal to adaptively modify said model in said model processor.

4. Method according to anyone of claims 1 to 3, characterized by using said material difference from said comparison to control the model in said model processor (6) updating said model to the actual sound environment in front of the eardrum.

5. Method according to anyone of the claims 1 to 3, characterized by using said material difference of the comparison as an error signal for a parameter adjustment processor (7) in said digital signal processing system for adjusting the process in said digital signal processor (2).

6. Method according to anyone of the claims 1 to 5, characterized by using said material difference from said comparison as an error signal for said parameter adjustment processor (7) to modify the model in said model processor.

7. Method according to anyone of the claims 1 to 5, characterized by using said material difference of said comparison as an error signal for said parameter adjustment processor (7) to adjust the transformation parameters of said digital signal processor (2) and said model function in said model processor (6).

8. Method according to anyone of the claims 1 to 7, characterized by using said material difference from said comparison as an error signal for a process in a microphone signal correction processor (9) connected between said sensing means (4) and said comparison means (5)

9. Method according to anyone of the claims 1 to 5, characterized by using said material difference from said comparison as an error signal to modify the transformed signal of said digital signal processor (2) in a modification means (8).

10. Method according to claim 1, characterized by using said at least one comparison means (5), said model processor (6) and said parameter correction processor (7) and even the said microphone signal correction processor (9) as at least parts of the electroacoustic model.

11. Method according to claim 1, characterized by using a probe microphone as said sensing means (4).

12. Method according to claim 1, characterized by using said receiver (3) as said at least one sensing means (4).

13. Hearing aid including means to measure and correct or adjust the sound signal presented to the eardrum in its operational position, including at least one microphone (1), at least one digital signal processing system comprising at least one digital signal processor (2) for transforming the incoming sound into a transformed signal in conformity with a desired transformation function, having at least one receiver (3) and a power supply, as well as at least one sensing means (4) for sensing the sound signal appearing in front of the eardrum, and at least one comparison means (5), characterized in that said signal processing system includes processing and storing means (6) for eventually holding a model function of the electoacoustic system of the ear and the hearing aid, simulating the actual sound signal in front of the eardrum,

14. Hearing aid according to claim 13, characterized in that the digital signal processing system also contains modification means (7; 8) for effecting, in response to said at least one error signal a modification of the output signal of the digital signal processor (2) into a corrected transformed signal, in case there is a material difference between said sensed signal and said simulated model.

15. Hearing aid in accordance with claim 13, characterized in that said modification means (8) in said signal processing system is arranged to receive said at least one error signal from said comparison means (5) to modify said transformed signal.

16. Hearing aid according to claim 13, 14 or 15, characterized in that said parameter adjustment processor (7) is one of the modification means (7; 8) in said signal processing system and is arranged to receive said at least one error signal from said comparison means (5) to adaptively modify the process in said digital signal processor (2).

17. Hearing aid according to claims 13, 14 or 15, characterized in that said parameter adjustment processor (7) as one of the modification means (7; 8) in said signal processing system is arranged to receive said at least one error signal from said comparison means (5) to adaptively modify the process in said model processor (6).

18. Hearing aid in accordance with claims 16 or 17, characterized in that said parameter adjustment processor (7) as one of the modification means (7;8) in said signal processing system is arranged to receive said at least one error signal from said comparison means (5) to adaptively modify the process in said digital signal processor (2) and in said model processor (6).

19. Hearing aid according to claim 13, characterized in that a microphone signal correction processor (9) is provided between sensing means (4) and the comparison means (5), said processor (9) being arranged to receive said at least one error signal from said comparison means (5) to adaptively modify the process in said microphone signal correction processor (9).

20. Hearing aid according to claim 13, characterized in that at least one comparison means (5), said model processor (6), said parameter correction processor (7) and even said microphone signal correction processor (9) are at least parts of the electroacoustic model.

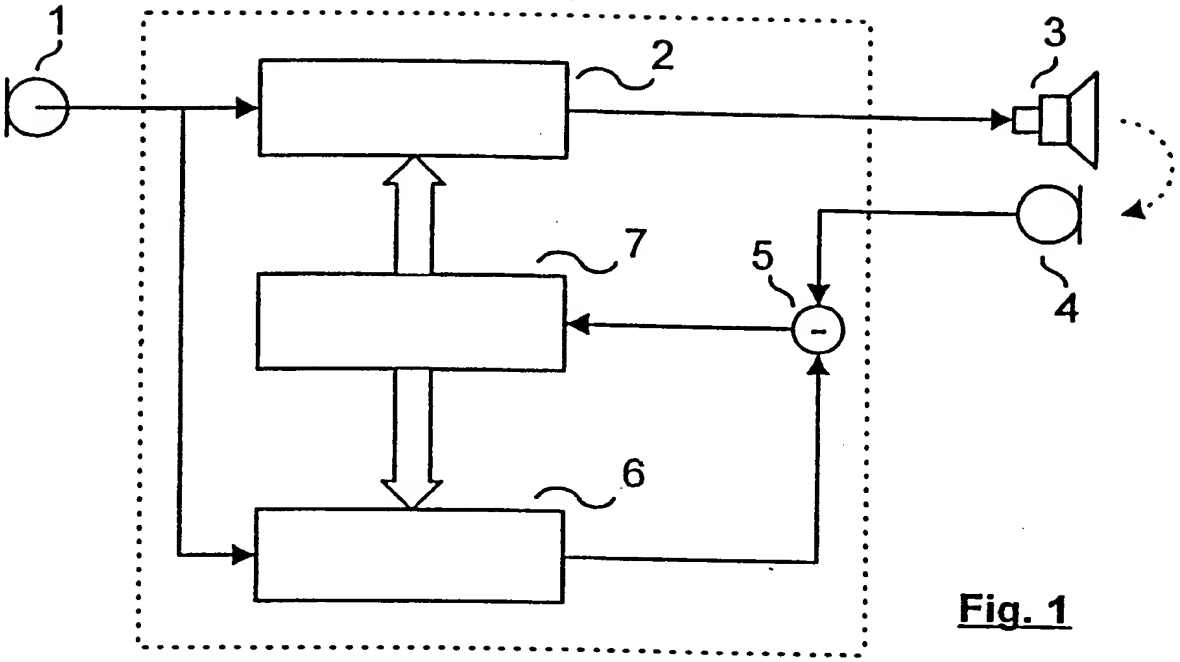

Fig. 1

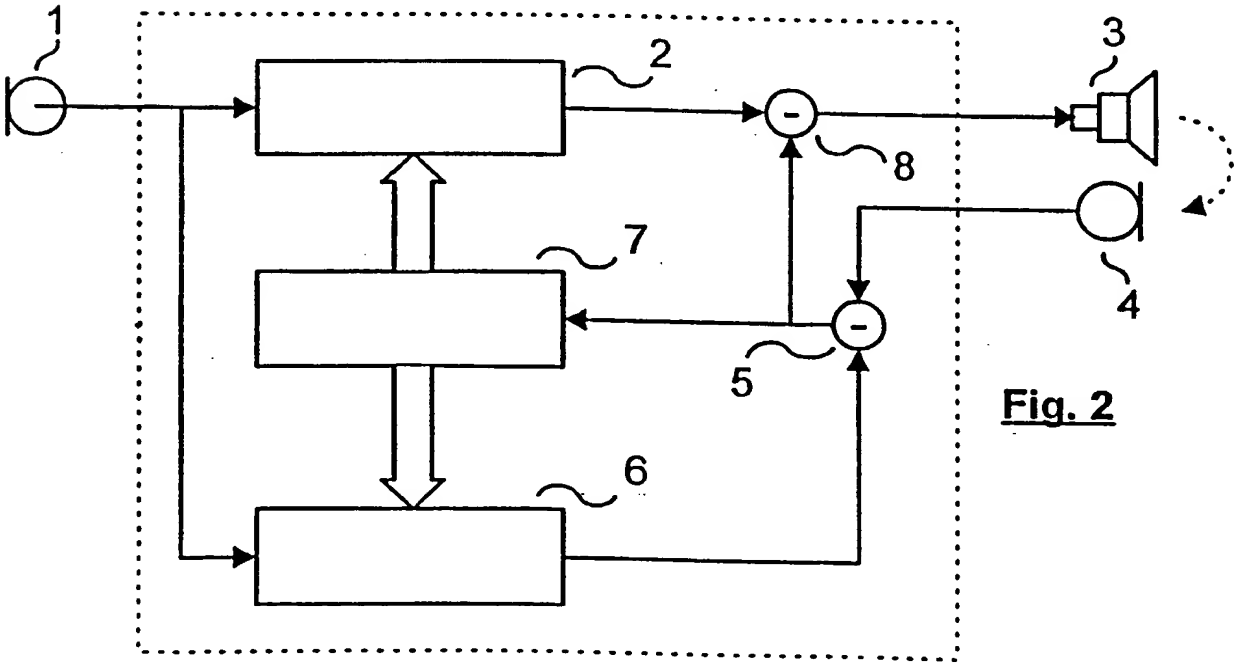

Fig. 2

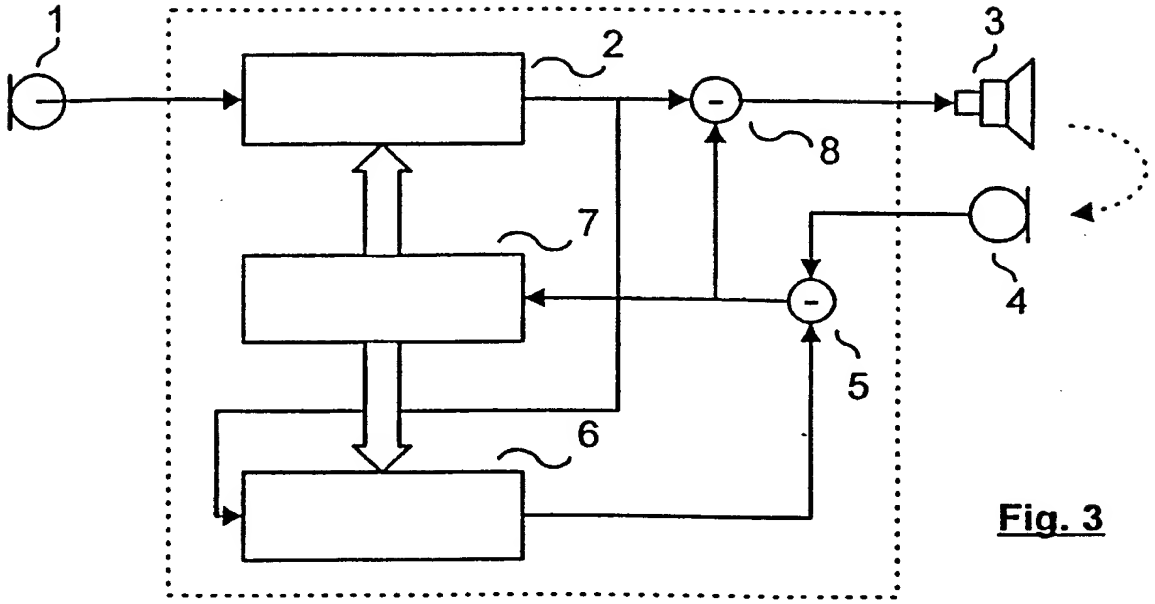

Fig. 3

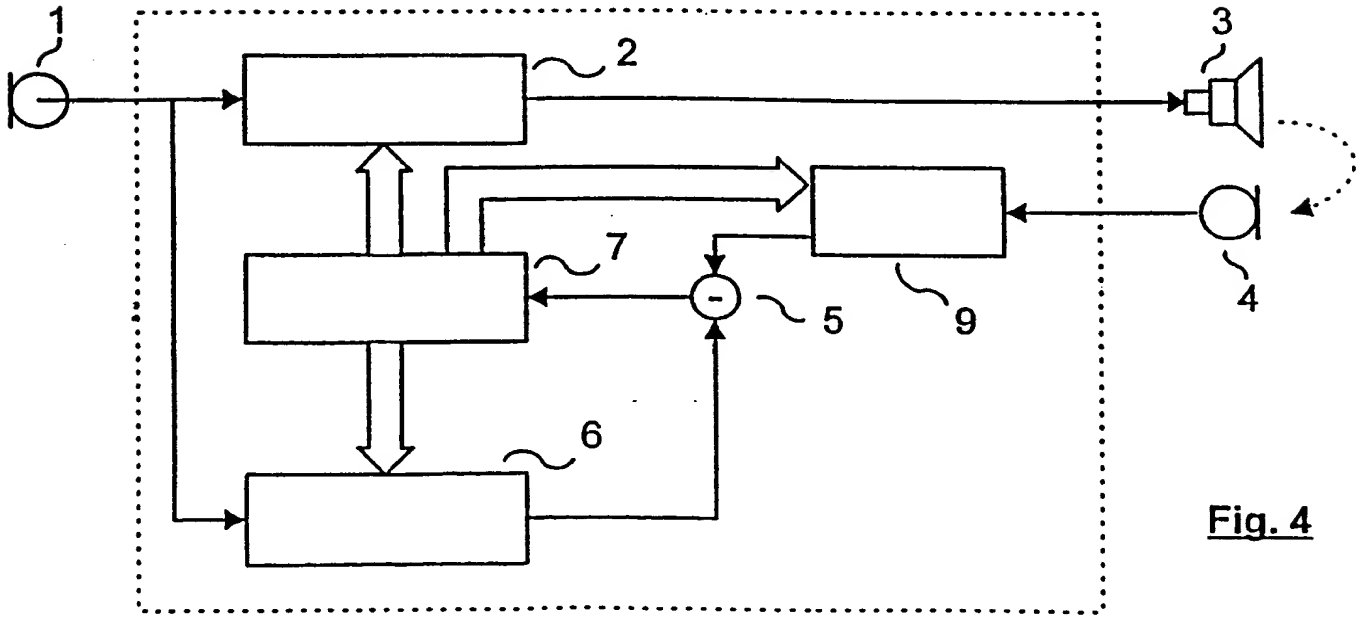

Fig. 4

INTERNATIONAL SEARCH REPORT

Intern. al Application No
PCT/EP 98/07131

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H04R25/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H04R A61B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 4 596 902 A (GILMAN SAMUEL) 24 June 1986 see column 1, line 7 - line 13 see column 3, line 39 - column 7 see column 9, line 3 - line 8; figures 1,2	13-16, 19,20
A	---	1
Y	WIDIN G P: "THE MEANING OF DIGITAL TECHNOLOGY" HEARING INSTRUMENTS, vol. 38, no. 11, 1 November 1987, page 28, 30, 32/33, 74 XP000611160 see page 30, right-hand column, last paragraph - page 34, right-hand column, last paragraph	13-16, 19,20
A	---	
	CH 624 524 A (PHONAK AG) 31 July 1981	1,13

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
25 June 1999	12/07/1999

Name and mailing address of the ISA	Authorized officer
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Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Internal Application No
PCT/EP 98/07131

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
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1

INTERNATIONAL SEARCH REPORT

Information on patent family members

Interna l Application No
PCT/EP 98/07131

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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CH 624524 A	31-07-1981	NONE	
DE 2808516 A	06-09-1979	NONE	